# Effects of a Structured Resource-based Web Issue-Quest Approach on Students' Learning Performances in Computer Programming Courses

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**ABSTRACT**

Programming concepts are important and challenging to novices who are beginning to study computer programming skills. In addition to the textbook content, students usually learn the concepts of programming from the web; however, it could be difficult for novice learners to effectively derive helpful information from such non-structured open resources. Few studies have addressed this issue by proposing different web issue-quest approaches and investigating the effects of learning with different web resources on students' learning performances in computer programming courses, not to mention the use of statistical methods for analyzing the factors affecting students' learning outcomes. Therefore, in this study, a structured-resource issue-quest approach is proposed to support structured programming learning activities. An issue-quest learning environment was developed, and an experiment was conducted to compare the learning achievement of the students who learned with the proposed approach (experimental group) with that of the students who learned with the conventional open-resource-based issue quest approach (control group). The participants were 418 tenth graders (214 in the experimental group and 204 in the control group) who were 16 years old on average. Structural Equation Modeling (SEM) was employed to investigate and compare the effects of the Web Issue-Quest approaches (i.e., open resource-based issue quest and structured resource-based issue quest) on the students' learning perceptions based on an extended technology acceptance model (ETAM). The experimental results showed that the structured resource-based issue quest approach benefited the novices more in terms of their learning achievements related to the computer programming concepts. Meanwhile, the SEM analysis showed that the two groups of students had equivalent perceptions of the usefulness, ease-of-use and enjoyment of learning with the two issue quest modes. This implies that the structured resource-based issue quest approach was helpful to the students in terms of improving their learning performance, while the limitation of access to open resources did not affect their learning perceptions.

**Keywords**

Computer programming, Issue quest, Structured resource, Technology Acceptance Model, Structural Equation Modelling

## Introduction

Computer knowledge and programming skills have been recognized as a core competence in the 21st century (Kirby & Riley, 2006). In the past decade, educational institutes all around the world have considered basic computer knowledge and programming skills as a fundamental curriculum at all school levels (Esteves, Fonseca, Morgado, & Martins, 2011; Jeon, Kim, Hong, & Kim, 2014; Kordaki, 2010). For example, in the United States, the issue of teaching computer programming languages in school has been widely discussed for decades (Soloway, 1993). In Taiwan, students learn basic computer knowledge since the third grade, and basic programming skills since tenth grade; moreover, many colleges consider computer programming language courses as a fundamental curriculum for all graduate students (Wang, Huang, & Hwang, 2015). In Thailand, the higher education sector of the Ministry of Education has promoted computer and information technology skills, including computer programming concepts and skills in colleges since 2000 (Chookaew, Wanichsan, Hwang, & Panjaburee, 2016).

Meanwhile, programming has been identified as a course with a high drop-out rate (Gomes, Areias, Henriques, & Mendes, 2008). Researchers have pointed out several factors affecting students' programming skills, including the lack of practice (Chen, Chang, & Wang, 2008) and insufficient or incorrect fundamental concepts of programming (Eckerdal, 2009). For example, students who lack the concept of the structure of programming are likely to write ill-structured programs (Ala-Mutka, 2004). In addition to their textbooks, most novices acquire computer and programming knowledge from the web, which provides non-structured open resources comprising various kinds of information. Therefore, many studies have reported the importance of conducting web-based learning activities for strengthening students' competences of acquiring knowledge (Kuo, Hwang, & Lee, 2012; Land & Greene, 2000; Rae & Samuels, 2011; Taradi, Taradi, Radić, & Pokrajac, 2005). The aim of facilitating

student-centered learning through web technologies is to foster students' abilities of data collection, extraction and application, as well as dealing with forthcoming challenges or problems (Ates & Cataloglu, 2007; Pimta, Tayraukham, & Nuangchalerm, 2009; Land & Greene, 2000). Researchers have called such web-based learning activities that engage students in searching for information on the web, selecting information, abstracting important and relevant content and summarizing their findings for investigating a specified issue or topic "Web Issue-Quest" (Sung, Hwang, & Chang, 2015).

Several previous studies have reported that students' Web Issue-Quest ability could be insufficient if they lack experience or are not well trained (Bilal, 2001; Bilal, 2002). Researchers have further indicated that the type of web resources could also be another important factor affecting students' learning perceptions and outcomes in Web Issue-Quest learning activities (Jonassen, 1991; Merrill, 1991); that is, in such an activity, the information sources play an important role. Students' learning perceptions and performances could be significantly affected by the structure and content of the information sources (Fessakis, Gouli, & Mavroudi, 2012; Taradi, Taradi, Radić, & Pokrajac, 2005; Tsai, Lee, & Shen, 2013).

However, few studies have been conducted to investigate the effects of learning with different web resources on students' learning performances in computer programming courses, not to mention the investigation of factors affecting their learning outcomes using statistical analysis (Jaeger & Adair, 2014; Senocak, 2009). Therefore, in this study, a structured resource-based web issue-quest approach is proposed to facilitate programming concept learning. An experiment has been conducted to evaluate the effect of the proposed approach on students' learning achievements and perceptions in the "structured programming" unit of a high school fundamental computer programming course.

## Literature review

The importance and strategies of teaching computer programming in schools have been widely discussed by scholars around the globe for decades (Robins, Rountree, & Rountree, 2003; Yang, Hwang, Yang, & Hwang, 2015). For example, Al-Bow et al. (2009) reported a game development strategy for teaching computer programming to high school students and teachers. Wang et al. (2015) conducted a project-based computer programming activity in a high school and found that mathematics-gifted students tended to have better learning outcomes than students who were not gifted in this area.

To further investigate the status of computer programming education around the globe, Lahtinen, Ala-Mutka and Järvinen (2005) conducted an international survey. They found that the Internet had become an important resource for learning computer programming. Consequently, scholars have suggested that the learning environment for programming should not be restricted to schools, but that online resources should also be incorporated into the programming curriculum (Gomes, Areias, Henriques, & Mendes, 2008). Among the various web-based learning approaches, Web Issue-Quest is widely adopted in school settings. It is a student-centered learning activity in which students search for new knowledge and learn subjects through a series of information seeking, selecting, abstracting and summarizing activities that eventually help them answer questions and comprehend the issue in depth (Kuo, Hwang, & Lee, 2012; Smith & Hung, 2017). The questions, ranging from easy to difficult, guide the learners through the process of gathering information, integration, and argumentation (Bradley et al., 2008; Golanics & Nussbaum, 2008; Oh & Jonassen, 2007).

To deal with a web-issue quest, students require the abilities of retrieving, recognizing and synthesizing information; moreover, they need to be capable of generating solutions based on the information they collect and organize (Brand-Gruwel, Wopereis, & Vermetten, 2005; Eisenberg, Johnson, & Berkowitz, 2010). In the meantime, by engaging students in such web-quest learning activities, teachers can observe how the students inquire about issues according to their existing knowledge. Via Web Issue-Quest learning activities, students are active in seeking information, collecting data, making selections, linking new and old knowledge, as well as developing and inferring based on their findings in the learning activity (Fleissner, Chan, Yuen, & Ng, 2006; Chan, 2007; Jwaifell & Al-Atyat, 2015). Researchers have indicated that such well-structured and guided inquiry activities are helpful to students in terms of developing their critical thinking ability (Choi, Lindquist, & Song, 2014; Kong, Qin, Zhou, Mou, & Gao, 2014; Martyn, Terwijn, Kek, & Huijser, 2014; Sommers, 2014).

Researchers have also pointed out that the provision of supportive resources for online courses could affect students' perceptions of web-based learning activities (Palmer & Holt, 2008; Ucar & Trundle, 2011). Jwaifell and Al-Atyat (2015) indicated that providing quality information sources is one of the important components in web-quest learning activities for promoting students' learning motivation and inquiry ability. Gordon and

Brayshaw (2008) further reported that web issue quest activities were helpful to students in terms of improving their learning achievements based on the experimental results in a university. Accordingly, such learning activities have great potential for contributing to students' acquisition of knowledge (Şendağ & Odabaşı, 2009; Spronken-Smith, Bullard, Ray, Roberts, & Keiffer, 2008).

As few studies related to information seeking or Web Issue-Quest have focused on the effect of such an approach on students' programming knowledge, or have compared the learning performance and perceptions of the students who engaged in web issue-quest activities using different information resources, this study aimed to address these issues in the "structured programming" unit of a high school computer course. Moreover, the TAM (Technology Acceptance Model) was adopted to evaluate the students' learning perceptions. The TAM, proposed by Davis (1986), is a widely adopted model for investigating users' perceptions of information systems. It provides a theoretical foundation that allows researchers to examine how external variables (e.g., the quality of the search environment or the user's perceived enjoyment) affect users' inner cognitions and attitudes (e.g., perceived ease of use and usefulness), thus resulting in behavioral intention to use information technologies (Davis, 1989; Venkatesh & Davis, 1996). Liaw and Huang (2003) further proposed an extended TAM Model by considering individual computer experience and the quality of the search systems. In this study, the extended TAM model of Liaw and Huang (2003) was adopted to more precisely investigate the perceptions of the students who learned with different web issue-quest resources.

## Structured and open resource-based issue quest systems

In this study, an open resource-based and a structured resource-based issue quest system were employed to support the web-quest activities. The two systems have similar functions and interfaces for both teachers and students. The only difference between them is the information source, as shown in Figure 1. In the open resource-based system, students search for information via a metasearch engine, which invokes the existing search engines, such as Google, to search for information on the Internet (Meng, Yu, & Liu, 2002). On the other hand, the structured resource-based system searches for information from a database of an educational system. The database contains more than 500,000 data items, including 75% science-related materials, around 20% social science-related materials, and around 5% related to computer science; in particular, approximately 3% of the resources are related to the learning content of computer programming.

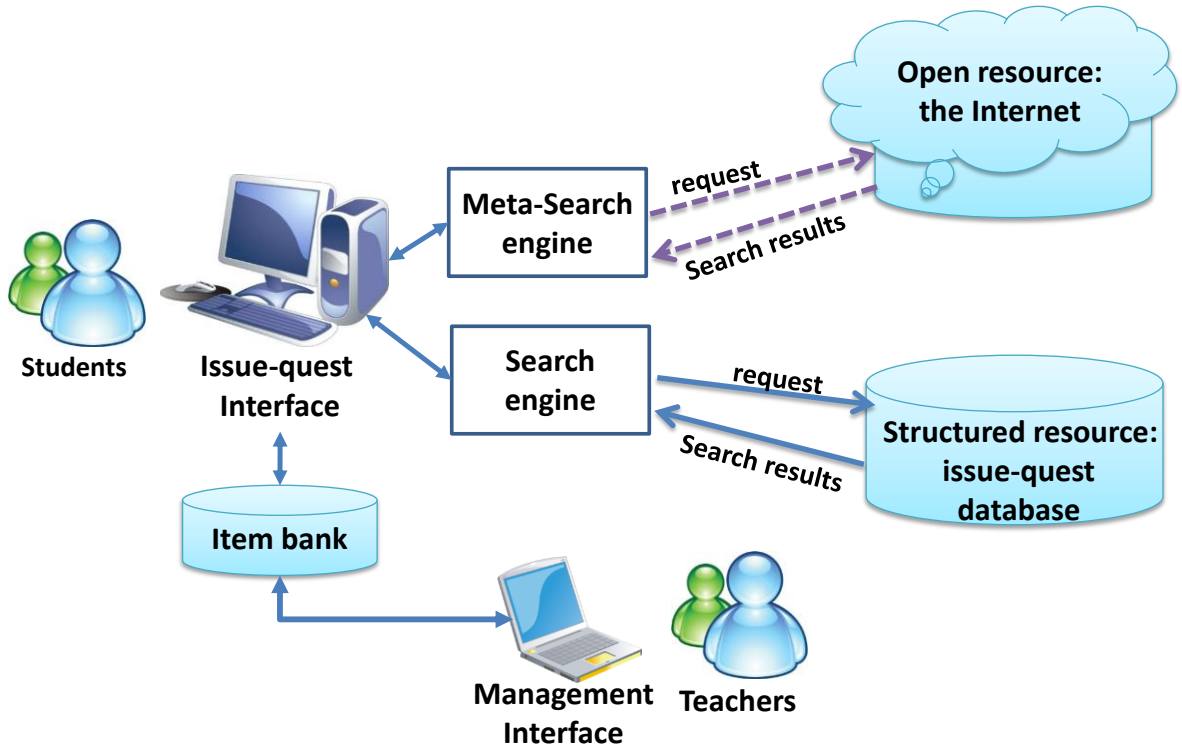


*Figure 1.* Structure of the web issue-quest learning system

Figure 2 shows the interface of the issue-quest learning system. The "question statement" area depicts the questions proposed by the teachers, while the "answer" area allows them to submit their answers to the questions

after invoking the "search" function to search for relevant information, select searched data, abstract relevant content, and summarize their findings. During the learning activity, the students first read the questions related to the quest issue on the left of the browser. They then fill in keywords to search for information for answering the questions. Following that, they need to select the searched results to browse, abstract relevant content to the answer area, modify the statements, and then submit their answers.

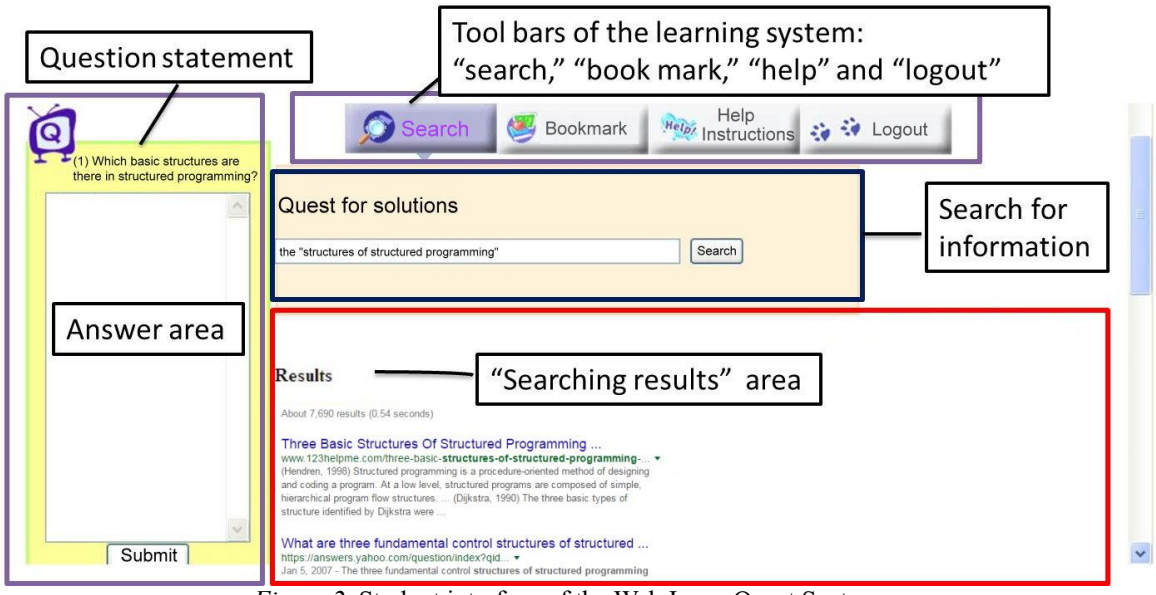


*Figure 2.* Student interface of the Web Issue-Quest Systems

### Research questions

In this study, we attempted to examine the learning achievement and perceptions of the students who learned with the structured resource-based and open resource-based issue quest approaches. Therefore, the following research questions were investigated:

- Do the students who learn with the structured resource-based issue quest approach show better learning achievements than those who learn with the conventional open resource-based issue quest?
- What are the perceptions of the students who learn with the structured resource-based issue quest from the perspective of the extended TAM model?
- What are the perceptions of the students who learn with the open resource-based issue quest from the perspective of the extended TAM model?

## Method

In this study, the course unit "basic concepts of structured programming" in a vocational high school was adopted for conducting the experiment. The objective of the unit was to foster the concepts of three basic programming structures (i.e., serial, selective, and repeated structure) and their application criteria.

### Participants

The subjects included twelve classes of tenth graders of a vocational high school in Taiwan. A total of 418 students, whose average age was 16, participated in the study. Six classes, totaling 214 students, were assigned to be the experimental group, while the other classes consisting of 204 students were the control group. The students in the experimental group learned with the structured resource-based issue quest approach, while the control group students learned with the open resource-based issue quest approach. There was no significant difference between the prior knowledge of the two groups because a pre-test had been conducted to confirm their related knowledge for this subject before the experiment. In addition, the IQ and background knowledge of the participants were seen as having no significant difference because they had just passed the entrance examination and had been assigned to the same school based on their performance in the examination.

**Experimental procedure**

Figure 3 shows the experimental procedure of this study. Before the learning activity, the students received 100 minutes of instruction on the basic concepts of the computer programming language. They then took the pre-test to evaluate their prior knowledge of learning structured programming. Following that, the teacher introduced the functions and operational procedure of the Web Issue-Quest systems and asked the students to practice operating the systems.

The web issue-quest activity lasted 100 minutes. During the learning activity, the students in the experimental group and the control group were engaged in answering the four questions using the open resource-based and the structured resource-based Web Issue-Quest systems, respectively.

After the learning activity, all of the students took a post-test and completed questionnaires on the perceived quality of the Web Issue-Quest systems as well as their enjoyment, ease of use, usefulness, and user intention regarding the learning activity.

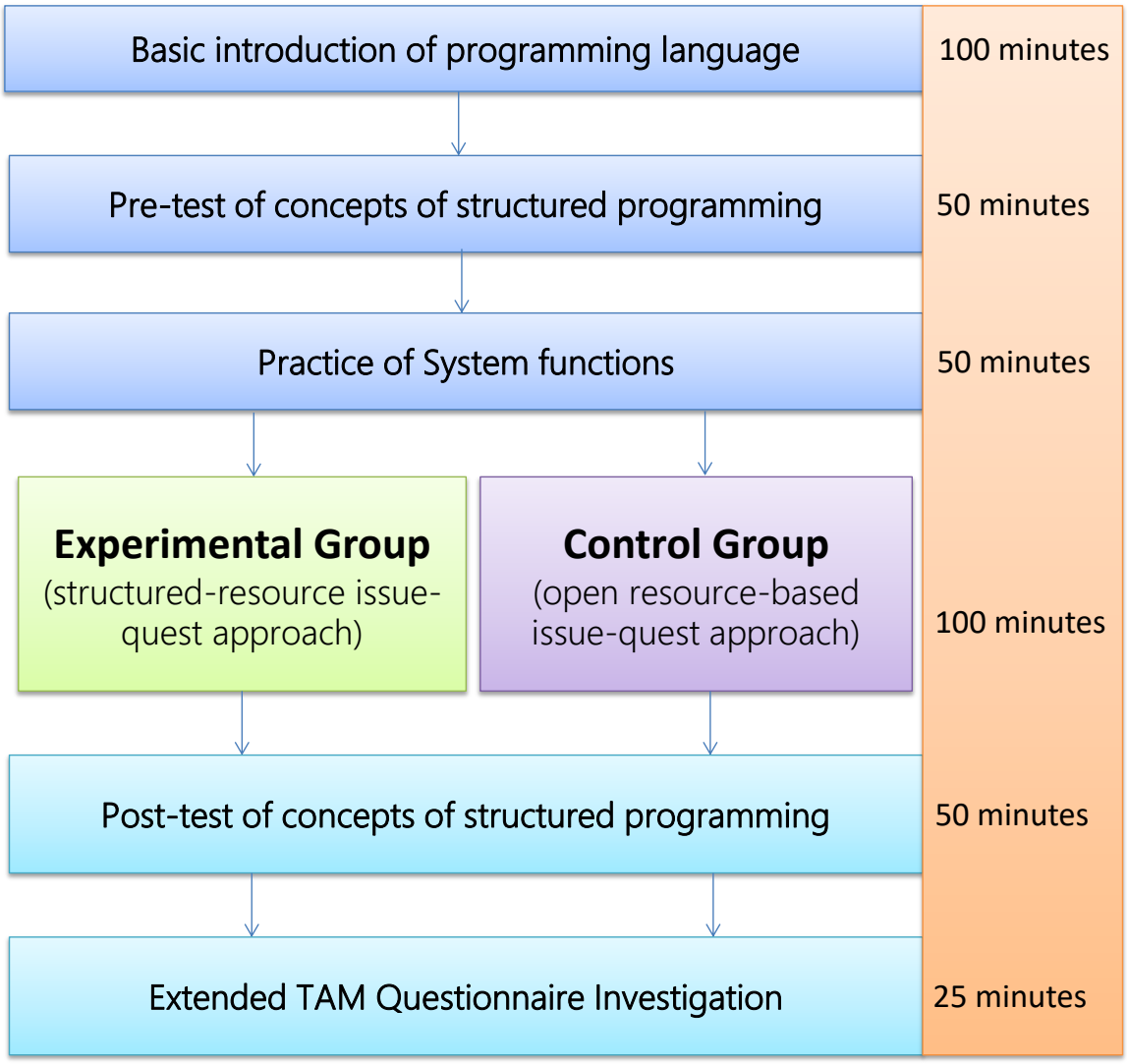


*Figure 3.* Experimental procedure

**Measuring tools**

The pre-test and post-test were developed by an experienced high school teacher who had taught the computer programming course for more than ten years. The aim of the tests was to examine the students' structured programming concepts. Each of the tests consisted of 15 multiple-choice and five short-answer questions with perfect scores of 100.

To assess the students' learning perceptions, a modified version of the extended Technology Acceptance Model proposed by Liaw and Huang (2003; 2006) was adopted as the measuring tool. A total of 15 items in the questionnaire were used to assess the five latent variables of the causal model, including the quality of the Web Issue-Quest system (QOS), perceived enjoyment (PE), perceived ease-of-use (PEU), perceived usefulness (PU), and user intention (UI), as shown in Table 1. A 7-point Likert scale was used in the questionnaire, where 1 represented "Strongly Disagree" and 7 represented "Strongly Agree." The Cronbach's α values were 0.95, 0.92, 0.88, 0.95 and 0.91 for system quality (QOS), enjoyment (PE), ease of use (PEU), usefulness (PU) and intention (UI), respectively.

*Table 1.* Five latent variables and their observed items

| Latent variables | Questionnaire items used as observed variables |
|---|---|
| Quality of the Web Issue-Quest learning system (QOS) | QOS1: I am satisfied with the information searching and resources. |
| | QOS2: I am satisfied with the quality of information generated from the information searching and resources. |
| | QOS3: I am satisfied with the functions of the information searching and resources. |
| Perceived Enjoyment (PE) | PE1: I am satisfied with using the information searching and resources to find online information. |
| | PE2: I like to use the information searching and resources to find information. |
| | PE3: I enjoy using the information searching and resources when I need to use them. |
| Perceived Ease of Use (PEU) | PEU1: It is easy to remember how to perform tasks using the information searching and resources. |
| | PEU2: My interaction with the information searching and resources is clear and understandable. |
| | PEU3: Overall, I find the information searching and resources easy to use. |
| Perceived Usefulness (PU) | PU1: Using the information searching and resources enhances my learning effectiveness. |
| | PU2: Using the information searching and resources makes learning more efficient. |
| | PU3: Overall, I find the information searching and resources helpful to me in acquiring knowledge. |
| User Intention (UI) | UI: I believe that the information searching and resources are effective for finding information. |
| | UI2: I will use the information searching and resources to find information. |
| | UI3: I intend to use the information searching and resources to find information in the future. |

**Question design for the Web Issue-Quest activities**

Previous studies have reported the question design principles for Web Issue-Quest activities (Hwang, Tsai, Tsai, & Tseng, 2008; Hsu, Hwang, Chuang, & Chang, 2012). Usually four questions are needed to guide students to investigate a specified issue via web information searching in a systematic way. The first, second, and third questions are structured problems for evaluating the students' information searching (Keyword-adopting and information-selecting), abstracting, and organizing performance (Connell & Abramovich, 2017). The fourth is an open question for engaging students in critical and creative thinking (Reasoning and elaborating) based on what they discovered from answering the other questions (Kuo, Hwang, Chen, & Chen, 2012; Kuo, Hwang, & Lee, 2012). Table 2 illustrates the four questions designed for this study. The students' cognition and concept of structured programming can be developed by dealing with the four Web Issue-Quest questions.

*Table 2.* Four questions for guiding students to investigate the concept of structured programming

| The concept of structured programming | Different information capacity |
|---|---|
| 1. Which basic structures are there in structured programming? | Keyword-adopting and information-selecting |
| 2. What are the basic procedures of those structures in structured programming? | Information-abstracting |
| 3. What are the advantages and disadvantages of structured programming? | Information-organizing |
| 4. Do you agree or disagree with utilizing structured programming? Why? | Reasoning and elaborating |

## Results

### Analysis of learning achievement

One of the objectives of this study was to examine the effectiveness of the proposed approach in terms of improving the learning achievement of the students. ANCOVA was used to exclude the difference between the prior knowledge of the two groups by using the pre-test scores as the covariate and the post-test scores as dependent variables. The homogeneity test result showed that the post-test scores of the two groups were homogeneous ($F = 0.25$, $p = .62 > 0.05$), implying that ANCOVA could be applied.

Table 3 shows the ANCOVA of the posttest scores of the two groups by excluding the impact of their pretest scores. It was found that the students in the experimental group had a higher adjusted mean (i.e., 13.84) than those in the control group with $F = 11.06$ and $p < .05$, showing that learning with the structured resource-based issue quest activity benefited the high school students more than learning with the open resource-based issue quest approach.

*Table 3.* The ANCOVA analysis of the posttest

| Group | *N* | Mean | *SD* | Adjust mean | *F* |
|---|---|---|---|---|---|
| Control group | 204 | 12.65 | 4.78 | 12.79 | 11.06* |
| Experimental group | 214 | 13.94 | 4.07 | 13.84 | |

*Note.* $^{*}p < .05$.

### Analysis of learning perceptions

Structural Equation Modeling (SEM) was adopted to analyze the data of the extended Technology Acceptance Model collected from the two groups of students who learned with the structured resource-based issue quest and the open resource-based issue quest approaches. The causal relationships of the modified model are shown in Figure 4, and the hypotheses are listed as follows.
Hypothesis H1: The quality of the system causes perceived enjoyment.
Hypothesis H2: The quality of the system results in perceived ease of use.
Hypothesis H3: The perceived ease of use causes perceived usefulness.
Hypothesis H4: Usefulness relates to enjoyment.
Hypothesis H5: Perceived usefulness increases users' intention to use the system.

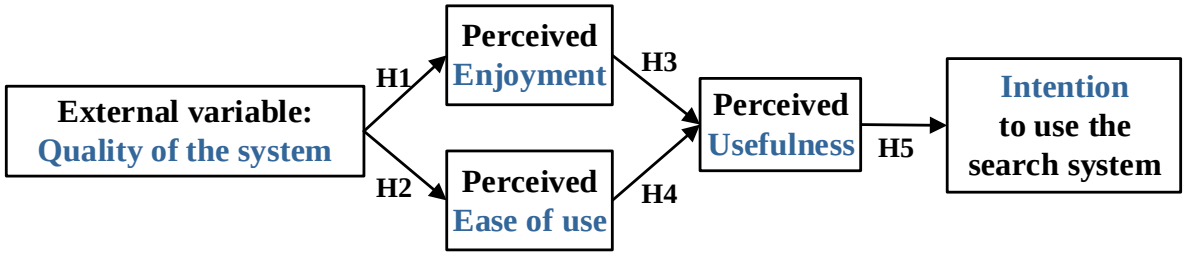


*Figure 4.* The SEM model of each group

*Measurement model*

The measurement model was used to assess the reliability and validity of the observed variables, as shown in Table 4. The measurement models were evaluated based on three parts, the significance of each estimated coefficient or loading, the convergent validity, and the discriminant validity. Firstly, all items loaded significantly on their latent constructs ($p < .01$). Hair et al. (2006) noted that an item is remarkable if its factor loading is greater than 0.50. In Table 4, the factor loadings (FL) of all the items in the measure range from 0.75 to 0.96, thus meeting the threshold (0.50), and demonstrating convergent validity at the item level.

Secondly, using composite reliability (CR) and average variance extracted (AVE) to evaluate the convergent validity, Fornell and Larcker (1981) suggested three phases for assessing convergent validity, including the item reliability of each measure, the composite reliability (CR) of each construct, and the average variance extracted (AVE). Nunnally and Bernstein (1994) noted that a value of .70 or higher is recommended to achieve adequate composite reliability (CR). The average variance extracted (AVE) is also an indicator of convergent validity. The

researchers have explained that the aim of the average variance extracted (AVE) is to measure the amount of variance captured by the construct in relation to the amount of variance attributable to the measurement error (Fornell & Larcker, 1981). A commonly used threshold value for average variance extracted (AVE) is 0.5 (Hair, Black, Babin, Anderson, & Tatham, 2006). As shown in Table 3, the convergent validity for the proposed constructs of this study is adequate when the value of AVE ranges from 0.66 to 0.88, exceeding 0.50. To sum up, the composite reliability (CR) and average variance extracted (AVE) both met the guidelines in Table 3. It is confirmed that the standardized coefficients show high validity and reliability in this study.

*Table 4.* Standardized coefficients for measuring the construct validity and reliability of the models of the two groups

| Latent variables (Construct) | Observed variables (Item) | Control group | | | | Experimental group | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Factor loading | E | CR | AVE | Factor loading | ε | CR | AVE |
| Quality of the Web Issue-Quest learning system (QOS) | QOS1 | 0.89 | 0.21 | 0.95 | 0.87 | 0.89 | 0.21 | 0.95 | 0.87 |
| | QOS2 | 0.96 | 0.07 | | | 0.96 | 0.08 | | |
| | QOS3 | 0.94 | 0.12 | | | 0.94 | 0.13 | | |
| Perceived Enjoyment (PE) | PE1 | 0.90 | 0.18 | 0.93 | 0.82 | 0.90 | 0.16 | 0.93 | 0.82 |
| | PE2 | 0.92 | 0.15 | | | 0.96 | 0.14 | | |
| | PE3 | 0.90 | 0.18 | | | 0.85 | 0.18 | | |
| Users' Intention (UI) | UI1 | 0.88 | 0.22 | 0.93 | 0.81 | 0.87 | 0.19 | 0.92 | 0.79 |
| | UI2 | 0.93 | 0.13 | | | 0.94 | 0.11 | | |
| | UI3 | 0.89 | 0.20 | | | 0.86 | 0.18 | | |
| Perceived Usefulness (PU) | PU1 | 0.84 | 0.30 | 0.91 | 0.77 | 0.93 | 0.29 | 0.96 | 0.88 |
| | PU2 | 0.87 | 0.24 | | | 0.95 | 0.23 | | |
| | PU3 | 0.92 | 0.16 | | | 0.93 | 0.15 | | |
| Perceived Ease of Use (PEU) | PEU1 | 0.87 | 0.24 | 0.86 | 0.66 | 0.83 | 0.18 | 0.91 | 0.78 |
| | PEU2 | 0.82 | 0.32 | | | 0.93 | 0.27 | | |
| | PEU3 | 0.75 | 0.44 | | | 0.88 | 0.36 | | |

Thirdly, the correlational method needs to be used for determining the discriminant validity. Tables 5 and 6 show the implied correlations between the variables, which were all higher than 0.7. When the indicator is more correlated with the measured construct than with other constructs, discrimination can be achieved (Fornell, Tellis, & Zinkhan, 1982); moreover, two constructs could be highly correlated but remain distinct. In this study, discriminant validity was satisfactory for all operationalizations; that is, the constructs were adequate since discriminant validity was achieved at all the item and construct levels. Therefore, the scales could be considered to be satisfactory for employing the SEM analysis.

*Table 5.* Correlation between the variables in the control group ($N$ = 204)

| Open resource-based issue quest | PE | UI | PU | PEU | QOS |
|---|---|---|---|---|---|
| Perceived Enjoyment (PE) | 1.00 | | | | |
| Users' Intention (UI) | 0.74** | 1.00 | | | |
| Perceived Usefulness (PU) | 0.84** | 0.88** | 1.00 | | |
| Perceived Ease of Use (PEU) | 0.49** | 0.54** | 0.61** | 1.00 | |
| Quality of the Web Issue-Quest learning system (QOS) | 0.77** | 0.63** | 0.72** | 0.64** | 1.00 |

*Note.* $^{**}p < .01$.

*Table 6.* Correlation between the variables in the experimental group ($N$ = 214)

| Structured resource-based issue quest | PE | UI | PU | PEU | QOS |
|---|---|---|---|---|---|
| Perceived Enjoyment (PE) | 1.00 | | | | |
| Users' Intention (UI) | 0.77** | 1.00 | | | |
| Perceived Usefulness (PU) | 0.85** | 0.91** | 1.00 | | |
| Perceived Ease of Use (PEU) | 0.64** | 0.70** | 0.78** | 1.00 | |
| Quality of the Web Issue-Quest learning system (QOS) | 0.82** | 0.72** | 0.80** | 0.77** | 1.00 |

*Note.* $^{**}p < .01$.

Table 7 shows the descriptive statistics analyzing the distribution of the quantitative data obtained from the questionnaire, including the means and standard deviations of each scale for the control and experimental groups. The mean scores of QOS, PE, PEU, PU, and UI were all greater than 4.0, ranging from a low of 4.59 to a high of 4.96. This indicates an overall positive response to the constructs. Both the learners in the control group and in the experimental group had a positive attitude toward the PBL support system they used; therefore, the means of each scale for the two groups are high and similar, so there are no remarkable differences between the

descriptive statistics of the two groups. The students in the experimental group have a similarly strong degree of perception as the students in the control group.

*Table 7.* The investigation results of each scale for the two groups

| Scale | Control group ($N$ = 204) | | Experimental group ($N$ =214) | |
|---|---|---|---|---|
| | Mean | *SD* | Mean | *SD* |
| Quality of the Web Issue-Quest learning system (QOS) | 4.92 | 1.19 | 4.90 | 1.21 |
| Perceived Enjoyment (PE) | 4.59 | 1.27 | 4.61 | 1.29 |
| Perceived Ease of Use (PEU) | 4.89 | 1.00 | 4.89 | 1.20 |
| Perceived Usefulness (PU) | 4.96 | 1.16 | 4.89 | 1.21 |
| Users' intention (UI) | 4.93 | 1.13 | 4.89 | 1.25 |

*Structural model*

The fit measures of the two-group structural model and correlation of the scales in both groups are shown in Table 8. For most fix indices, the fit values were remarkably good. Only the fit index values of RMSEA and Standardized RMR were in the "acceptable" range. Consequently, an acceptable model fit was derived.

It was also found that all of the correlation coefficients were positive and less than 1.0, implying that all of the hypotheses related to the construct-to-construct relationships were accepted.

*Table 8.* Fit measures for the two-group structural model

| Fit index | Fit values for two-groups | Recommended value |
|---|---|---|
| Degrees of Freedom (DF) | 175 | - |
| Minimum Fit Function Chi-Square ($\chi^2$) | 558.02 ($p$ = .00)<br>control group = 258.15<br>experimental group = 299.87 | - |
| $\chi^2$/DF | 3.39 | < 5.0 |
| Percentage Contribution to Chi-Square | Control group = 46.26%<br>Experimental group = 53.74% | |
| Root Mean Square Error of Approximation (RMSEA) | 0.095 | < 0.08 |
| 90 Percent Confidence Interval for RMSEA | (0.086 ; 0.11) | |
| P-Value for Test of Close Fit (RMSEA < 0.05) | 0.00 | |
| Goodness of Fit Index (GFI) | 0.86 | ≥ 0.90 |
| Standardized RMR | 0.084 | ≤ 0.05 |
| Normed Fit Index (NFI) | 0.97 | > 0.9 |
| Non-Normed Fit Index (NNFI) | 0.98 | > 0.9 |
| Comparative Fit Index (CFI) | 0.98 | > 0.9 |
| Relative Fit Index (RFI) | 0.97 | > 0.9 |
| Incremental Fit Index (IFI) | 0.98 | > 0.9 |
| Parsimony Normed Fit Index (PNFI) | 0.81 | > 0.8 |

To sum up, this study tested the hypothesized model modified from the model proposed by Liaw and Huang (2003) and from the literature; therefore, the findings have theoretical underpinnings. Based on the analysis results in Table 8, the hypotheses of the direct relationships H1, H2, H3, H4, and H5 in Figure 4 were all supported. Accordingly, Figure 5 and Figure 6 reveal the obtained results of the hypothesized structural mode for the experimental group and the control group.

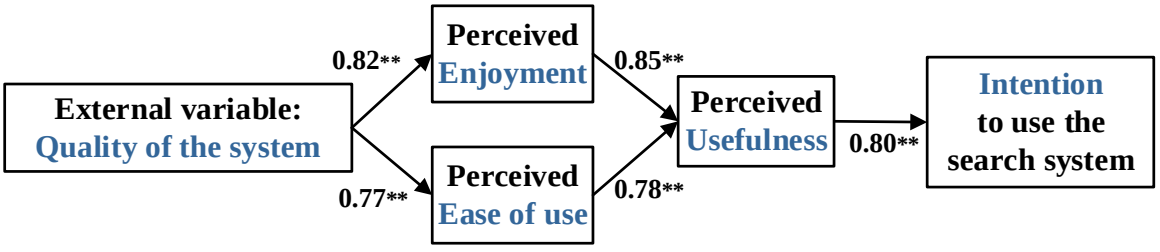


*Figure 5.* Structural model of the experimental group

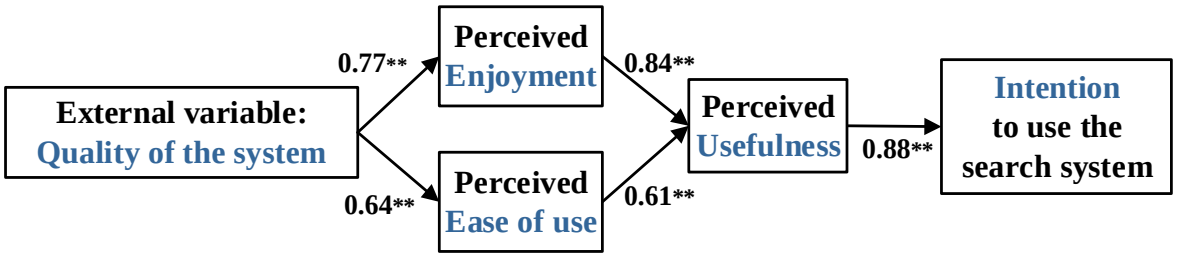


*Figure 6.* Structural model of the control group

The following concludes the two structure models. The external variable, the quality of the Web Issue-Quest learning system (QOS), in the structured resource-based issue quest mode (i.e., the experimental group) had strong causal relations with perceived enjoyment (PE) and perceived ease of use (PEU). In the two constructs, it was found that perceived enjoyment (PE) had similar causal relations with perceived usefulness (PU) in the two groups. In particular, perceived ease of use (PEU) in the structured resource-based issue quest mode (i.e., the experimental group) in Figure 6 had a stronger causal relation to perceived usefulness (PU) than the open resource-based mode; on the other hand, the open resource-based issue quest mode showed a relatively stronger causal relation from perceived usefulness (PU) to intention to use (IU).

## Discussion and conclusions

In this study, a structured Web issue-quest approach was proposed and applied to a high school computer programming course. The experimental results showed that the students who learned with the proposed approach had significantly better learning achievements than those who learned with the conventional approach. This finding conforms to the report of Riahinia and Zandian (2008) who indicated that a large proportion of students (63.4%) preferred accessing well-structured learning resources (e.g., online databases or e-libraries) than searching for information on the Internet when they were novices in a field. Therefore, it is suggested that, to improve students' learning efficiency for specified issues, teachers can consider adopting the structured resource-based issue quest (i.e., the information searching system in the experimental group).

Meanwhile, it was found that the students' perceived enjoyment, perceived ease of use, and perceived usefulness were key determinants of behavioral intention. These results agree with the finding of Giannakos and Vlamos (2013) who investigated the acceptance of educational websites and suggested that instructors and educational institutions should focus on usefulness and ease of use. The results of this current study also showed that the students had strong perceptions of the ease of use and the usefulness of the Web Issue-Quest activity, no matter whether they used the open resource-based or the structured resource-based mode for learning the basic concepts of structured programming. That is, both modes of Web Issue-Quest learning engaged the students in learning with high intention.

On the other hand, it was found that the structured resource-based Web Issue-Quest method was more effective than the open resource-based method for the students' learning achievement, but no difference was found between the two methods in terms of their perceptions. One of the reasons for obtaining such opposite results could be due to the fact that the interfaces for both systems were identical, although the sources of the searched data were totally different. Such a finding is similar to what was reported by Hwang, Sung, Hung and Huang (2013), who found that most students' preferences regarding using computer systems were highly related to the system interfaces.

To sum up, the main contribution of this study is proposing and showing the effectiveness of engaging students in structured resource-based Web Issue-Quest environments for computer programming courses. From the analysis results of the students' learning achievements and perceptions, it was found that the structured resource-based method was more beneficial to the students than the open resource-based method; meanwhile, the students had equivalent perceptions of the two methods. These findings provide a good reference for those teachers and researchers who intend to conduct Web Issue-Quest learning activities based on solid evidence obtained by conscientious data analysis. That is, the provision of a structured data source is important for improving students' learning outcomes, and the design of the user interface could be the major factor affecting their perceptions of using the learning system.

On the other hand, the research limitation of this study needs to be noted. In this study, the learning approach was designed by taking the needs of novice learners into account, and hence the findings might not be able to be

inferred to all learners. In the future, it would be worth conducting additional studies to further investigate the impacts of the proposed approach on students with different personal factors, such as computer experience, knowledge levels and learning styles. It could also be interesting to take different user interface strategies into consideration.

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